Space Weather Technical Forecast

Issued on Saturday 8 February 2025 at 13:00 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: R1/R2 likely throughout. G1/Minor storm likely from Day 2 (09 Feb).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with one M-class flare, peaking at M2.0 at 08/0927 UTC from AR3981 in the northwest quadrant.

There are ten active regions on the Earth-facing disc. The majority of interest is in the northwest with a cluster of entwined regions containing AR3976, AR3977, AR3978, AR3981 and AR3984. Of these, AR3981 remains the largest and most complex region on the visible disc, with two notable delta regions in the intermediate portion. AR3981, and the rest of the spots in the northwest have show signs of decay in recent imagery, most significantly from AR3978, AR3984 and AR3981 with their intermediate spots fading. The spots within this northwestern cluster are close together and it is difficult to define the exact boundaries of each region. As such they are magnetically interconnected, with interaction between the various regions. The remaining regions on the disc are small and simple at present.

A partial halo CME was present in coronagraph imagery in the early hours of 08 Feb, this has good confidence that its far-sided and isn't expected to produce any impacts at Earth.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE and DSCOVR at L1, observed speeds at slow ambient levels, around 350km/s. The density was initially well below average, on a slight rising trend becoming below average. The Interplanetary Magnetic Field, Bt, was initially weak, around 5nT with a slight rising trend to become moderate, peaking at 10nT. The north-south component, Bz, initially varied between -2/+5nT. Between 08/0730 and 08/0930 UTC the Bz was positive, peaking at 7nT. Then from 08/0930 UTC the Bz became predominantly southwards directed falling to -8nT. The phi angle was mostly positive (away from the Sun). Geomagnetic activity was mainly Quiet (Kp 0-1) with a brief Unsettled (Kp3) interval between 08/0600-08/0900 UTC.

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 remained at background levels.

High energy electron flux (greater than 2MeV) at GOES16 was at mostly background to moderate levels. The associated 24-hour fluence persisted below the Active threshold on a flat trend, recording 3.7e6 integrated pfu at 08/0000UTC.

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Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is expected to continue, with a slight chance of an X-class flare, primarily from the cluster of regions in the northwest.

Solar Wind / Geomagnetic Activity: There is a slight chance of up to three glancing CMEs through the period, one on Day 1, and the other two on Days 3 or 4.

Solar winds are currently slow-ambient. The next feature, the High Speed Stream from CH13/-, is expected to arrive during Day 2 (09 Feb), perhaps more likely during the second half of the day, lasting into Day 3 (10 Feb). Solar winds are expected to become elevated to potentially strong at 500-600 km/s.

Predominantly Quiet to Unsettled (Kp 0-3) geomagnetic activity is expected, with a slight chance of Active to G1/Minor Storm intervals if we do see any CME influence on Day 1. Activity is then expected to increase from Day 2 (09 Feb) due to a connection to the HSS from CH13, likely becoming Active to G1/Minor storm (Kp4/5) with a very slight chance of G2/Moderate storm intervals (Kp6). On Day 4 (11 Feb) likely continuing with the Active to G1/Minor storms, with the combined risk of the CME arrivals and potential connection to another HSS from CH14.

Energetic Particles / Solar Radiation: There is a slight chance of S1/Minor radiation storm events as the cluster of sunspots in the northwest are now in a good position to connect with Earth, should there be further large flares. High energy electron flux observed at GOES16 is expected to be mostly at background levels, perhaps with a rising trend on Day 4 (11 Feb). The corresponding 24 hour fluence is expected to persist below the Active threshold.

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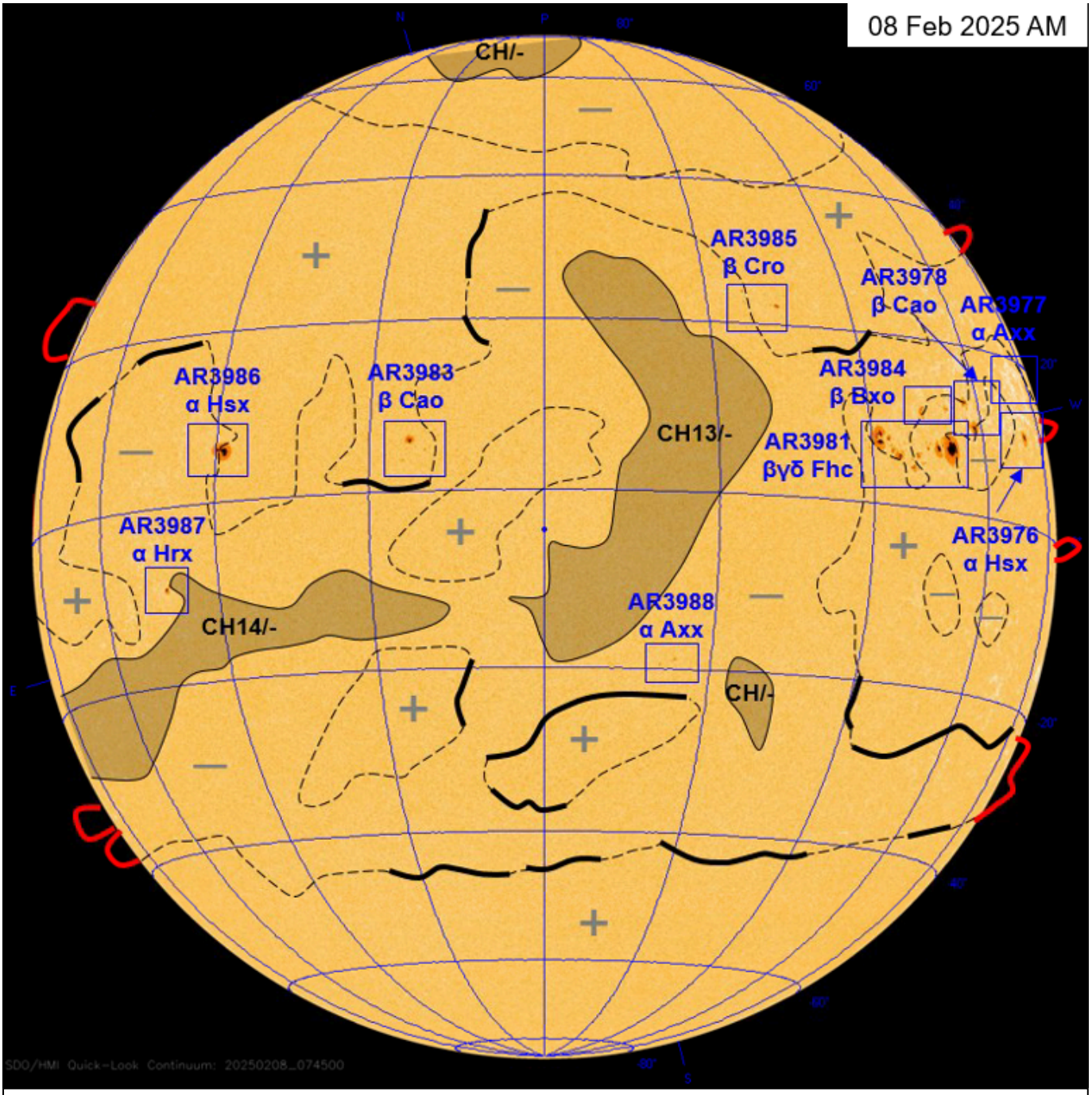
Figure 1: Solar Synoptic Map valid 08/0745 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

A CME may cause a glancing blow during Day 1 (08 Feb), which originated from a filament eruption in the southwest early on 05 February, this is subject to a fair amount of uncertainly with no signs of its arrival at Earth at present. There is a slight chance of up to two glancing blows from faint CMEs associated with two M7 flares on 06/07 Feb, which may arrive at Earth late on Day 3 (10 Feb) and into the early hours of Day 4 (11 Feb). A partial halo CME was present in coronagraph imagery in the early hours of 08 Feb, this has good confidence that its far-sided and isn't expected to produce any impacts at Earth.

Solar winds are currently slow-ambient, around 350km/s. The next recurrent feature, the High Speed Stream from CH13/-, is expected to arrive during Day 2 (09 Feb), perhaps more likely during the second half of the day, lasting into Day 3 (10 Feb). This feature appears to be larger and more intense compared to the previous rotation, when speeds reached around 450 km/s. On this rotation solar winds are expected to become elevated to potentially strong at 500-600 km/s, in line with MOSWOC Enlil expectations. However, Enlil appears to be too early in its onset of the HSS arrival at Earth. This is expected to be shortly followed by a connection to a HSS from CH14/-, again a reoccurring feature with solar winds again becoming Elevated into the end of Day 4 (11 Feb).

Predominantly Quiet to Unsettled (Kp 0-3) geomagnetic activity is expected, with a slight chance of Active to G1/Minor Storm intervals if we do see any CME influence on Day 1. Activity is then expected to increase from Day 2 (09 Feb) due to a connection to the HSS from CH13, likely becoming Active to G1/Minor storm (Kp4/5) with a very slight chance of G2/Moderate storm intervals (Kp6). On Day 4 (11 Feb) likely continuing with the Active to G1/Minor storms, with the combined risk of the CME arrival and potential connection to a HSS from CH14.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	60	50	60
Strong	G3	No	1	5	5	5
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
07/0200	Partial	AR3981	NW	300	10/2100 +/-12 hours	Low confidence.
07/2100	Partial	AR3981	NW	300	11/0000 +/-12 hours	Low confidence.

Figure 2: MOSWOC Enlil output. The shown onset of the HSS is believed to be too early.

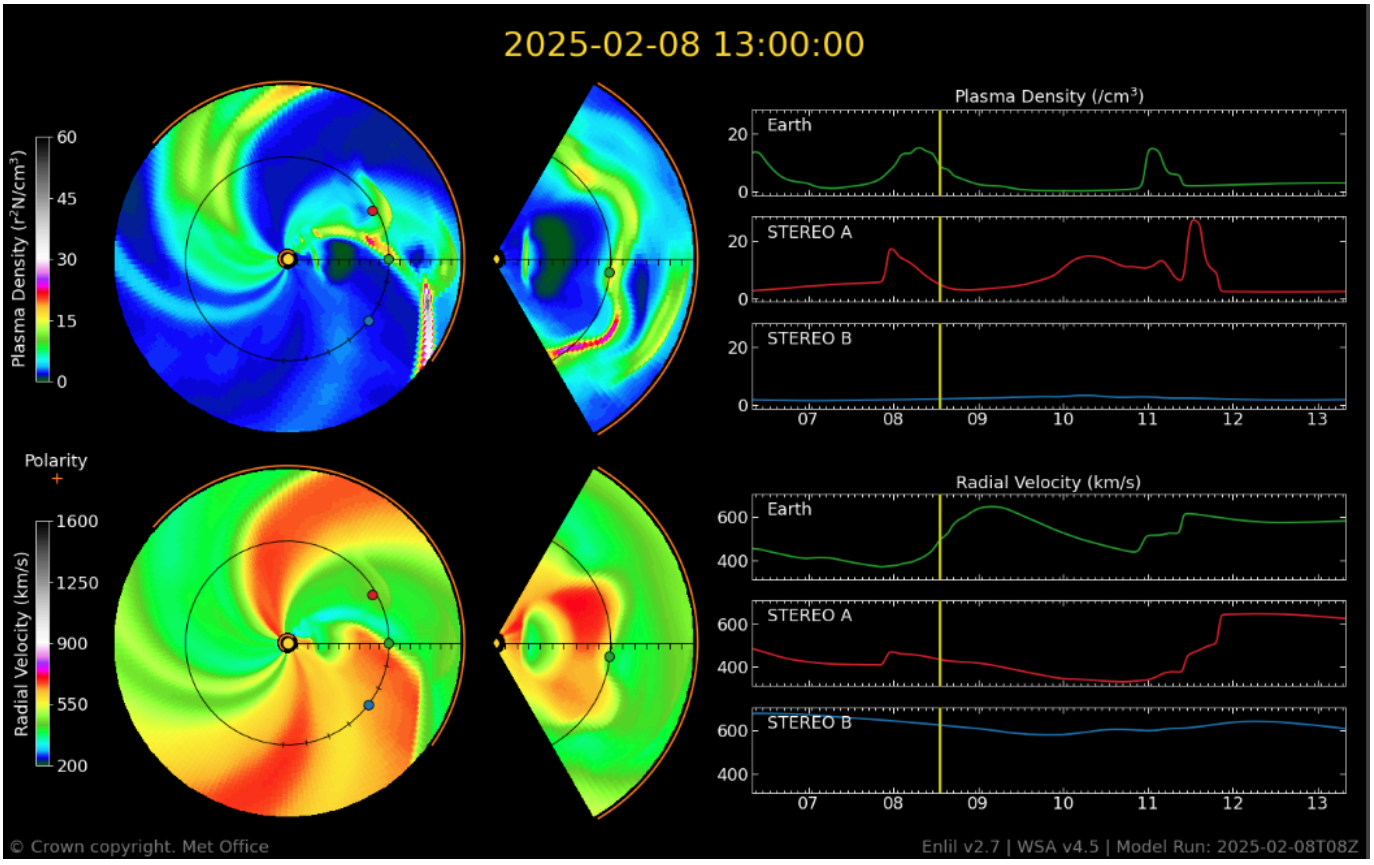

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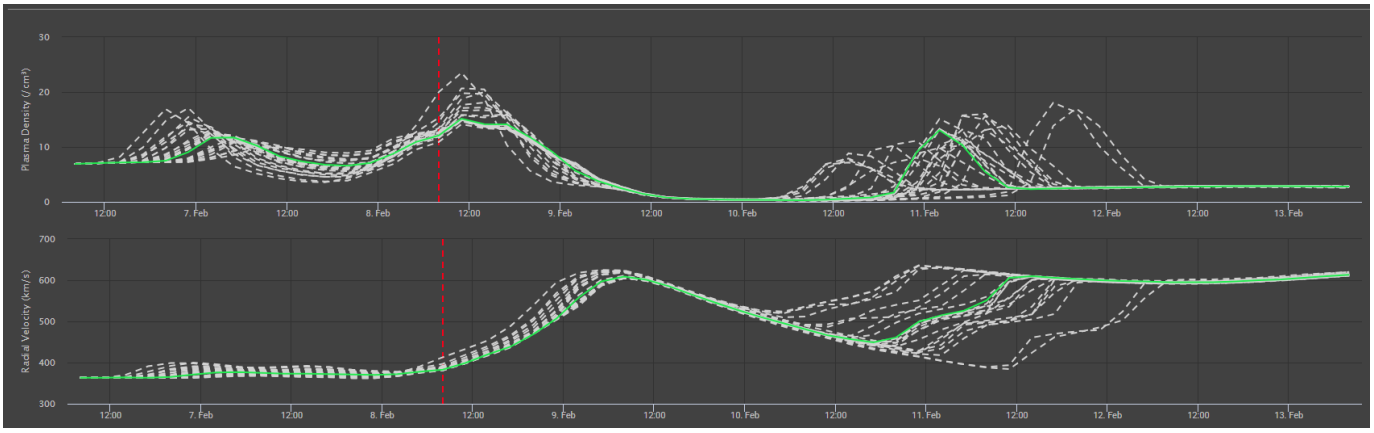
Figure 3: MOSWOC Ensemble showing the onset of the HSS from CH13 at the start of the period and a widespread of solutions for potential CMEs arriving at Earth later in the period.



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Radio Blackouts - X-Ray Flares

Solar activity has eased in the last 24 hours, although remains moderate with one M2.0 flare at 08/0927 UTC from AR3981 in the northwest quadrant.

There are ten active regions on the Earth-facing disc. The majority of interest is in the northwest with a cluster of entwined regions containing AR3976, AR3977, AR3978, AR3981 and AR3984. Of these, AR3981 remains the largest and most complex region on the visible disc, with two notable delta regions in the intermediate portion. AR3981, and the rest of the spots in the northwest have show signs of decay in recent imagery, most significantly from AR3978, AR3984 and AR3981 with their intermediate spots fading. The spots within this northwestern cluster are close together and it is difficult to define the exact boundaries of each region. As such they are magnetically interconnected, with interaction between the various regions. The remaining regions on the disc are small and simple at present.

While AR3981 is likely to rotate of the western limb by the end of the period, SDO/AIA 171 imagery shows notable looping around the eastern limb and combined with far-sided data suggests several complex regions are soon to appear. As a result the forecast probabilities of significant flares remain steady throughout.

Further M-flares are likely, with a slight chance of an isolated X-class flare.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	70	70	70	70
Very Active	R3-R5 (X Class)	No	20	20	20	20

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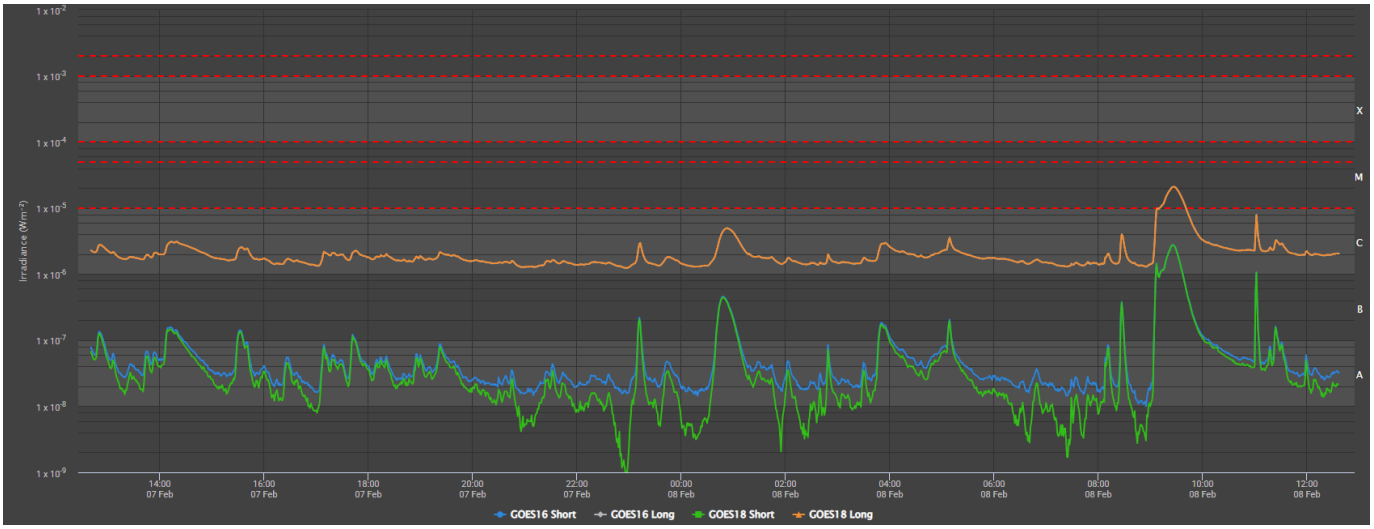
Figure 4: X-ray trace from GOES16&18 over the last 24 hours.



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Solar Radiation Storms (High Energy Protons)

The northwestern cluster of sunspots, including AR3981, is now in a good position to connect with Earth and produce an increase in proton flux after any large flares. That said, none of the more notable flares have so far proven proton-rich, therefore the overall risk is remained at a slight chance of reaching above the S1/Minor radiation storm threshold throughout the period.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	20	20
Very Active	**≥ S3 ***	No	5	5	5	5
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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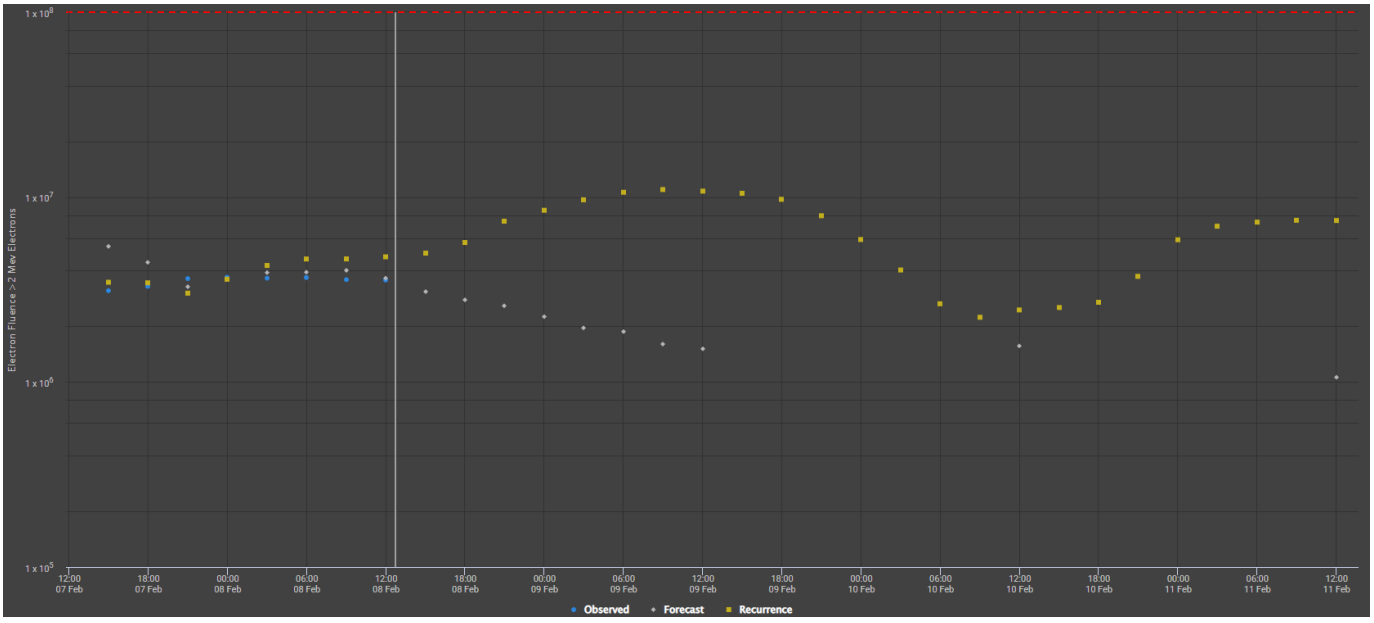
High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 has been at mostly background to moderate levels. The next likely charging mechanism for the Van Allen belts is CH13/-, but any subsequent significant rise in electron levels is expected to be beyond the current forecast period. Possible CME arrivals in the interim complicate this picture somewhat, but overall mostly background electron flux is expected with perhaps a slight chance of a rise later on Day 4 (11 Feb).

The corresponding 24-hour fluence is expected to persist below the Active threshold through this period, perhaps with a rising trend later on Day 4. MOSWOC REFM output shows levels well below Active through the next 72 hours, however this will not account for intervening CMEs nor the increased intensity of CH13/-.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ 1×10^{8}**	No	1	1	1	5
Very Active	**≥ 2 MeV ≥ 1×10^{9}**	No	1	1	1	1

Figure 5: MOSWOC REFM output.



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